

once in several hours. During all its intermediate flights the molecule is exposed during the daytime to the full glare of radiation as intense as direct radiation from the sun's photosphere. In this way the internal motions of the molecule will be kept for some hours excited to intense activity, and if during these hours that special kind of encounter happens to take place which affords an opportunity for an interchange between the internal and translational energies, the two encountering molecules will fling asunder with what may be described as explosive violence. All that is then necessary for a molecule to escape is that one of the two that have encountered shall have the direction of its flight outward, that it shall have sufficient speed, and that it shall escape other encounters. If the chance that these events shall happen befalls each molecule in the penultimate stratum of the helium atmosphere as often as once in several days, there would probably be an abundant outflow of helium from the earth to account for the observed rate of its escape.

Here, however, we are on debatable ground. We can only follow events in detail with probability, not with certainty. But on the other hand, when we trust to the inductive argument based on the ascertained behavior of helium, as stated in an earlier paragraph, *we are on secure ground*. We may rely on the conclusion to which it leads, viz: that helium is escaping from the earth's atmosphere, and that the rate of escape is the same as the rate of the net inflow from the earth into the atmosphere. By the net inflow is meant the supply after deducting something like $1/6000$ or $1/3000$ part of the whole, in order to allow for the very minute quantity of helium that had been washed out of the atmosphere by rain and which is being restored to it.

There are other matters, too, which would need to be understood and allowed for before we should be entitled to trust the deductive method of proof. Thus, the internal events that go on within the molecules of matter are of more than one kind, and in gases stand differently related to the translational motion. This is revealed to us by phosphorescence and other phenomena. An attempt to make a preliminary classification of these internal events has been made by the present writer in a memoir on the kinetic theory of gas.⁷ But without going into these and other matters, enough has been said to show how inadequate the deductive method is—at least as hitherto handled—to be a safe guide in dealing with the matters with which it has been made to grapple. This, of course, also shows that objections based on investigations of this character have no weight against the testimony about the rate at which gases do actually escape from atmospheres which is given by such *facts* as the absence of atmosphere from the moon and the behavior of helium upon the earth.

The objection urged by Mr. Cook against accepting the inductive proof of the actual rate of escape of gases from atmospheres is analogous to the objection urged by some scientific men when in 1867 I brought forward a proof⁸ that in an atmosphere of mixed gases the atmosphere of each gas must have a different limit, the lighter constituents overlapping and extending beyond those that are denser. "Oh," it was then said "that can't be the case. It is inconsistent with Dalton's law of the equal diffusion of gases". Yet I have lived to see my conclusion generally, I believe universally, accepted by physical astronomers; and I look forward with some hope to an ultimate acquiescence in what is now being objected to in reference to escape of gases from atmospheres. In both cases the objection rests on the same error—the mistake of hypoth-

esis for theory, and the consequent mistake of a law which is approximate for a law of nature.

THE COORDINATES OF THE UNITED STATES WEATHER BUREAU STATION AT MOUNT WEATHER, VA.

By HERBERT HARVEY KIMBALL, Librarian and Climatologist.

This station is located on the summit of the Blue Ridge Mountains, in Loudoun County, Va. As determined from the Harpers Ferry contour sheet of the United States Geological Survey, its latitude is $39^{\circ} 4'$ north, its longitude $77^{\circ} 53'$ west from Greenwich. The location and surroundings of the station are shown on fig. 1.

No precise leveling has been done in this locality by either of the Government surveys. The Southern Railway has determined grades and elevations on its branch line from Alexandria to Bluemont, Va., the latter point being only about six miles from the Mount Weather station. Unfortunately, the profile constructed from the railway surveys is in two sections. The first extends from Alexandria to Round Hill, Va., the original terminus of the road; the second is the extension from Round Hill to Bluemont. The point of connection between the two sections is not clearly defined, and for this reason doubt was entertained as to the accuracy of the elevation of Bluemont as determined from these profiles.

The nearest Government survey bench mark is at Point of Rocks, Md., about 30 miles from Mount Weather, and the Chief of the Weather Bureau therefore instructed me to run a line of levels from this bench mark to Mount Weather. That part of the survey between Bluemont and Mount Weather was made in August, 1904, the remainder in November following. With the exception of about twelve miles of railroad between Bluemont and Paeonian Springs, Va., most of the route followed the country roads, on which at many points the grade was exceedingly steep.

Starting from the top of the upper end of a railroad culvert just east of the station at Bluemont, the summit of the Blue Ridge was reached by way of Snickers Gap, and the county road near the summit followed to the Mount Weather station. Here the outer corner of the top of the north foundation pier of the water tower was selected as a bench mark.

As a check upon this part of the work, which was the most difficult of all, and also to determine heights in the valley immediately below the Weather Bureau station, the survey was extended down the side of the Blue Ridge to Trapp, Va., and then back to the starting point at Bluemont by way of the Loudoun Valley. The difference in elevation between the culvert at Bluemont and the bench mark at Mount Weather was found to be 1019.903 feet by way of the mountain road and 1019.981 feet by way of Trapp and the valley road, a difference of only 0.078 of a foot. This is considered very satisfactory in view of the fact that on the mountain it was impracticable to make backsights and foresights equal in length on account of the steep grade, the many short turns in the road, and the obstruction of the view by trees.

From the railroad culvert at Bluemont to Paeonian Springs, Va., the survey was along the track of the Southern Railway, and foresights and backsights were made equal in length by counting the ties between stations. At Paeonian Springs we left the railroad and followed the highway to Point of Rocks, Md., by way of Waterford and Taylorstown, Va., crossing the Catoclin Mountains after leaving Taylorstown. The foresights and backsights were kept as nearly equal in length as was possible from eye estimates of distance.

There were few opportunities to check the accuracy of this part of the survey. The exact location of stations occupied by the railroad engineers could be determined in only a few cases. My determination of the height of a nearly level piece of track just west of Hamilton, Va., is 1.4 feet higher than the

⁷ "Of the kinetic theory of gas as illustrating nature". By G. Johnstone Stoney, F. R. S. Scientific Proceedings of the Royal Dublin Society, June, 1895, vol. 8, p. 356; or Philosophical Magazine, October, 1895, p. 362.

⁸ "On the physical constitution of the sun and stars". By G. Johnstone Stoney, F. R. S. Proceedings of the Royal Society, No. 105, p. 1, 1898. See, especially, paragraphs 23, 24, 25.

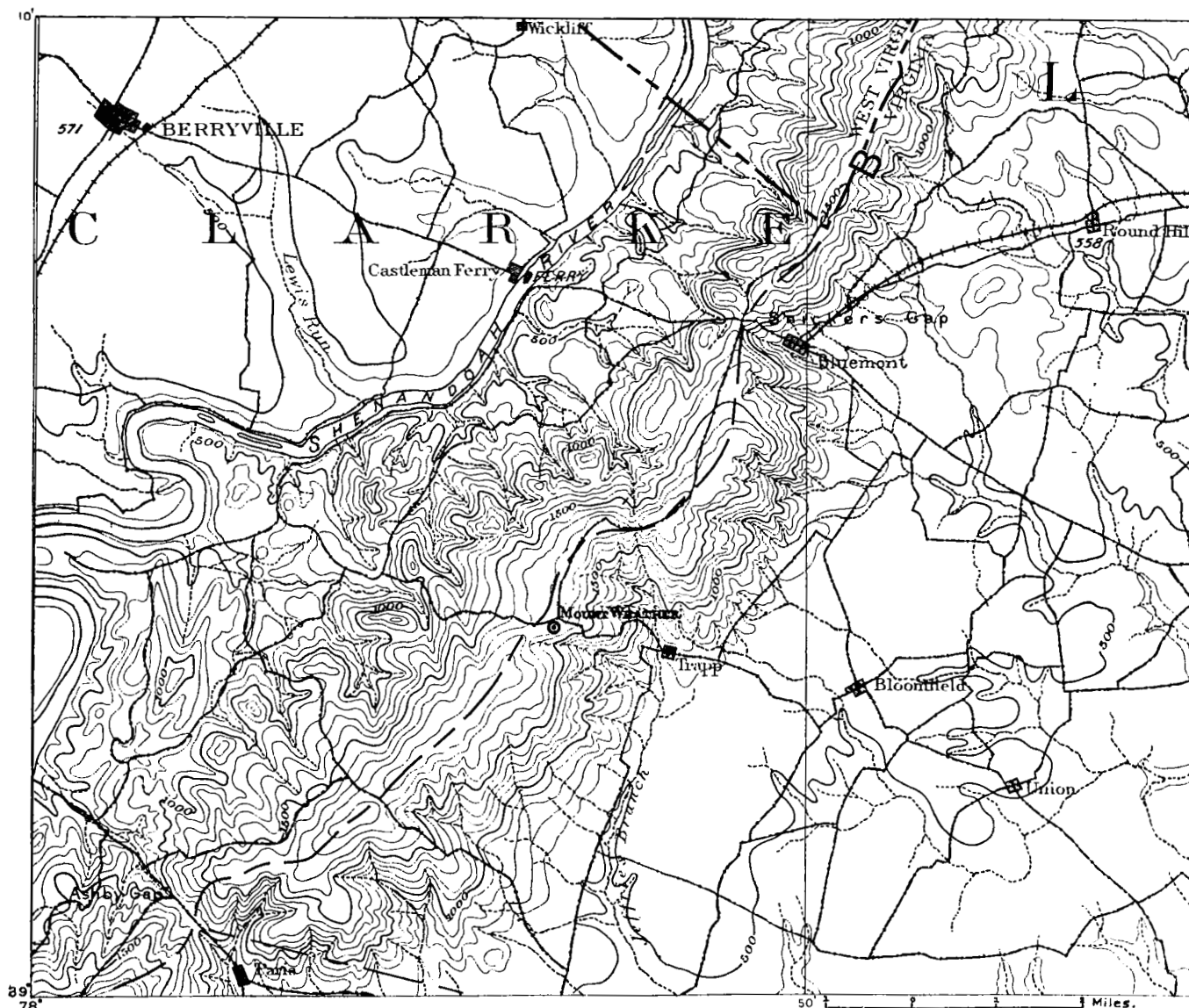


FIG. 1.—The location and surroundings of Mount Weather, Va.

This map is copied from the contour map of the U. S. Geological Survey. By the courtesy of the Southern Railway, the extension of their line from Round Hill to Bluemont is shown. Mount Weather has also been added, and the name of Bluemont substituted for the obsolete name, Snickersville.

railroad figures, and I also found the trestle at Round Hill to be 1.5 feet higher than it is given on the railroad profile. The Weather Bureau survey, therefore, checks with the railroad survey over this six miles of track to within 0.1 of a foot. The Weather Bureau survey shows the rise on the heavy grade just west of the Round Hill trestle to be about eight feet more than is apparently shown on the two railroad profiles. This discrepancy is believed to be due to the fact that the profiles of the two sections of the road do not quite come together. The omission from either profile of a short piece of roadbed at this point, where the grade is very steep, would account for the discrepancy.

A Gurley 20-inch engineer's level was used throughout the work. On the survey between Bluemont and Mount Weather an old direct reading rod was employed, the errors of which have since been determined by the U. S. Bureau of Standards, and the field notes of the survey have been corrected accordingly. For the remainder of the survey a very accurate New York rod was kindly loaned by the U. S. Geological Survey.

As a check on the record, two books of field notes were kept. A reading of the rod was first made and recorded by the rodman, Mr. Bertram J. Sherry; a reading was then made and recorded in a separate book by myself, and the two records

were at once compared. Discrepancies of more than 0.001 of a foot were investigated. The two records were separately worked up for the final results, but the discrepancies amounted to only 0.003 of a foot.

Considering the results of all the checks available, and of safeguards employed, it is not believed that the elevations given in the following summary are in error by more than 0.1 of a foot.

Stations.	Elevation above sea level in feet.	
	U. S. Weather Bureau survey.	Southern Railway survey.
U. S. Geological Survey bench mark B. & O. 44*, Point of Rocks, Md.	233.323	
Railway track near Hamilton, Va.	458.425	457.0
East end of railway trestle, Round Hill, Va.	546.529	545.0
Top of upper end of railway culvert, Bluemont, Va.	705.837	696.53(?)
Top of outer corner of north foundation pier to water tower, Mount Weather, Va., by way of mountain road.	1725.740	
The above by way of Trapp.	1725.818	
Mean	1725.779	
Barometer cistern below bench mark	0.698	
Height of barometer cistern at Mount Weather, Va.	1725.081	

The little town of Trapp, at the immediate foot of the Blue Ridge on the Loudoun County (east) side, and about one and one-third miles from the Weather Bureau station, is over 1000 feet lower, its elevation above sea level being less than 700 feet. On the west side of the mountain the fall is less abrupt. According to the U. S. Geological Survey contour map the distance from the Mount Weather station to the nearest point on the Shenandoah River is about three miles, and the elevation of the river is between 300 and 400 feet. More exact determinations in the Shenandoah Valley will no doubt be made later.

THE PROPOSED COMPETITION IN FORECASTING AT LIEGE.

[Translation.]

UNIVERSITY OF CLERMONT,

METEOROLOGICAL OBSERVATORY OF PUY DE DOME,

CLERMONT-FERRAND, January 27, 1905.

Prof. WILLIS L. MOORE,

Chief U. S. Weather Bureau, Washington, D. C.

SIR: You have been pleased to communicate to me the letter written by you on January 7, last, to Mr. Jacobs, president of the Belgian Astronomical Society¹, in reply to the letter in which he invited you to become a member of an international jury charged with judging in a competition in weather forecasting which the Belgian Astronomical Society proposes to organize.

In accordance with your desire, I hasten to give on the subject the views which you do me the honor to request.

First of all, I had nothing to do with the editing of the document, or rather the proposed document, which was sent to us, and in forwarding my acceptance to Mr. Jacobs I made some express reservations and indicated especially that, in my opinion, the jury, when definitely constituted, should alone be qualified to decide upon the programme. I even made my acceptance conditional upon that of Mr. Teisserenc de Bort; convinced as I was in advance that if that eminent scientist consented to make one of the jury, his influence would be sufficient to have erased from the proposed programme whatever might be unscientific and give rise to well founded opposition.

I had not been consulted either as to my possible participation in the jury, and I should not have failed to protest—as you have done—if they had given my name as a member of the jury in a printed document destined to be given to the public; but I understood that it was only a proposed programme, and that in making use of my name in a printed proof I was left perfectly free to accept or to decline the invitation, and it was the same with all the others whose names appeared with mine.

Having given these preliminary explanations, it is very easy for me to tell you how heartily I am in accord with you as to the injury that is done to science by these fantastic prophets who, without any knowledge of the general movements of the atmosphere, forecast the coming weather somewhat after the manner of those who tell fortunes with cards, and whose blunders do not succeed in exhausting the credulity of the the public. It is necessary at any cost to prevent these from taking any part in a serious competition; and it was, in my opinion, very unfortunate that to the provision for a competition in forecasting for a proximate period they should have added a provision for forecasts several weeks in advance. It is evident that in the present state of science no such prediction can be made scientifically. My intention was to ask, in conjunction with Mr. Teisserenc de Bort, with whose ideas on these subjects I am well acquainted, the absolute elimination of this part of the programme, or rather this "side issue" added to the programme. I thought, however, that this side of the question could be more advantageously discussed when the jury had been constituted.

Again, I entirely agree with your view and those of Mr.

Pernter when you say that it would be impossible to accept results, even if they should be excellent in themselves and verified by experience later, without knowing the methods by which they have been obtained; and I am firmly convinced that no prize should be adjudged to a meteorologist for forecasts for very short periods in advance, unless he explains the details of his methods in such a way that afterwards any one else may be able to make use of it just as well as he.

The point upon which I take the liberty of differing with you, however, is in regard to the utility of a practical test by the author himself of a method of short-range forecasting. This question was discussed at the thirty-second meeting of the French Association for the Advancement of Science, held at Angers in 1903; the seventh section (Meteorology and Physics of the Globe), of which I had the honor to be president, formulated the following resolution:

"The seventh section, impressed by apparently proper methods for increasing the accuracy of weather predictions for short periods in advance, expresses the wish that the administration may give to the authors every facility for applying their methods under the most favorable conditions, and by appropriate tests, such as a competition, should allow competent scientists to pronounce as to the efficacy of these methods."

This resolution was adopted unanimously.

I can not but think that, in the present state of science, the prediction for the immediate future of depressions and centers of high pressure over Europe might be made with more precision than is ordinarily the case. Without entering into personal details, I may say that at this Congress of Angers the Section of Meteorology of the French Association was deeply impressed with the accuracy of certain forecasts applied to past conditions, and the French Association for the Advancement of Science, without itself taking the initiative for a competition, was won over to the idea that if those who think they can improve the methods of forecasting were put to the test and forced to apply their methods to a real prediction it would furnish the means of distinguishing that which is real progress from that which is only a repetition of what has been already done.

We do not lack persons who have general and very rational rules for predictions—to which indeed no objection can be made—but who, when charged with applying these rules, do not succeed in producing anything more than indications that are too vague to be of any real use. If those who think they can do better agree to submit to a severe test, and to explain afterwards their method of procedure, so that, by following them, others can derive profit from it, I can see in this only an excellent opportunity to separate what is serious and worthy to be called scientific from what is not. We must only take precautions. It will be especially necessary to abandon all idea of long-range forecasts, and carefully avoid anything that can furnish grounds for the criticisms—often so well founded—formulated by yourself and Mr. Pernter; but I think that the competition in itself, particularly if scientists of the standing of Mr. Teisserenc de Bort watch over it and exercise a control over its acts, would give rise to an exchange of ideas and discussions that would conduce to progress.

Believe me, dear sir, that this difference of opinion as to the utility of a competition for forecasts for very short periods does not prevent me from recognizing the correctness of your remarks, and I beg you to accept the assurance of my highest regard.

(Signed)

BERNARD BRUNHES,

Director of the Observatory.

SOLAR HALO OF FEBRUARY 3, 1905, AT WASHINGTON, D. C.

By ERIC REX MILLER, Weather Bureau.

A solar halo observed at Washington, D. C., on February 3, 1905, deserves mention on account of its permanence and brilliant coloration; and especially because it was accompanied

¹ See Monthly Weather Review, November, 1904, p. 523.